

*Teachers used the media that best supported the learning goal.*

*Annually at each site, new technology was available and project goals changed somewhat.*

*Because not all teachers were involved all five years of the study, we viewed data collectively, documenting overall shifts.*

This qualitative study utilizes data from 32 elementary and secondary teachers in five schools located in four different states. The ACOT classrooms represent the diverse populations and conditions found in contemporary public schooling. Each of these sites began with one classroom in the fall of 1986, adding classrooms, staff, and students in subsequent years.

Site	Grades	Teachers	Students	Community/Socio-Economic Status
1	1-4	8	180	Suburban/High Income
2	5-6	7	180	Rural/Middle Income
3	4-6	4	90	Inner-City/Low Income
4	4 & Sp. Ed.	4	80	Suburban-Urban/Low-Middle Income
5	9-12	9	120	Urban/Low-Middle Income

Table 1. *The status of each ACOT study site in the spring of 1990.*

The elementary classes are equipped with Apple IIe, IIGS, and Macintosh® computers. The high school is an all Macintosh installation. In addition to the computers, classrooms are equipped with printers, scanners, laser disks and videotape players, modems, CD ROM drives, and hundreds of software titles.

The technology is used as a tool to support learning across the curriculum. No attempt is made to replace existing instructional technologies with computers. By design, the classrooms are true multimedia environments where students and teachers use textbooks, workbooks, manipulative math materials, white boards, crayons, paper, glue, overhead projectors, televisions, pianos, as well as computers. The operating principle is to use the media that best supports the learning goal.

The ACOT project provides a variety of supports for teachers with the goals of increasing teachers' knowledge of theories on teaching and learning, expanding their technical expertise, and encouraging them to share acquired knowledge and skills. This support ranges from holding conferences and training workshops to providing technical equipment and professional release time. In addition, all sites are linked by a telecommunications network, called AppleLink®, that permits teachers to communicate with teachers at other sites as well as the Apple ACOT staff.

*The relationship between teacher interaction and instructional activities are investigated.*

*Five stages of instructional evolution are identified as Entry, Adoption, Adaptation, Appropriation and Invention.*

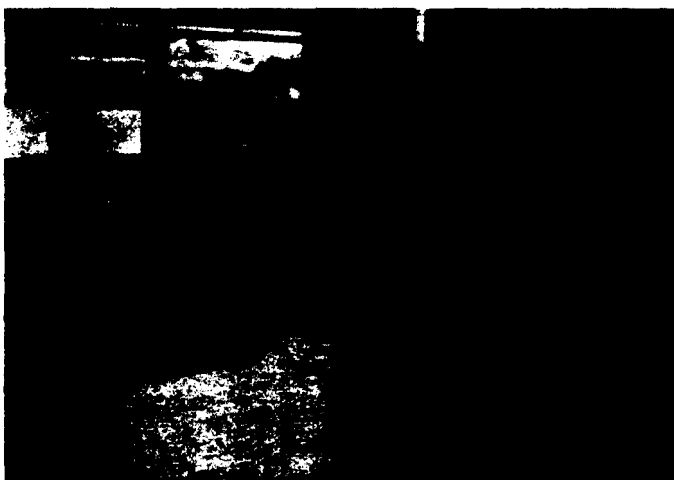
*In the entry stage, teachers had little or no computer experience and didn't want to change instruction.*

*At first, teachers used technology to replicate traditional learning activities.*

## Data Collection

The sources of data for this study, covering from October 1985 through June 1990, include weekly reports sent via electronic mail; correspondence between sites, and bi-monthly audio tapes on which teachers reflected about their experiences. Although this study does not include observational data, systematic observations by independent researchers support the self-report data reported in this investigation (Gearhart, Herman, Baker, Novak, & Whittaker, 1990; Tierney, 1988).

The data have been divided into two databases, which together have nearly 20,000 entries. A relational database, *Double Helix*, allows the data to be organized in a number of ways (e.g., by teacher, by school site, by dates, by thematic categories). Because the project spans five years, some of the teachers represented in the database were not involved for this entire time. Thus, simply examining individual teachers' data in terms of chronological dates could be misleading. At some sites, teachers worked with the same group of teachers and students over several years, while at other schools the key players changed more frequently. Each year of the project brought about additional changes in site organization, in the types of available equipment, and in project goals. Rather than examining change within individual teachers over time, we viewed the data collectively, documenting general trends related to collegial interaction during the evolution of the project. (For a thorough discussion of the data collection strategies and methodology used in this study, please see Dwyer, Ringstaff, Sandholtz, Keirns, & Grant, 1990).



*Teachers already enjoying collegial interaction use new technology more quickly.*

Early teacher interaction was informal for emotional support.

Using technology increased interactions as teachers sought technical help from each other.

Sharing experiences through electronic mail provided other opportunities for teacher interaction.

This report deals primarily with the collegial interaction among teachers rather than instructional changes. However, the two areas are closely related. Figure 1 displays the new patterns of teaching and learning that emerged over time. This progression can be viewed as an evolutionary process similar to other models of educational change (e.g., Berman & McLaughlin, 1976; Giacuinta, 1973; Gross & Herriott, 1979). The five stages of instructional evolution in the ACOT classrooms include: Entry, Adoption, Adaptation, Appropriation, and Invention. In this model, text-based curriculum delivered in a lecture-recitation-seat work mode is first strengthened through the use of technology and then gradually replaced by far more dynamic learning experiences for the students. (For a more thorough treatment of the changes in instructional practices, see Dwyer, Ringstaff, & Sandholtz, 1990).

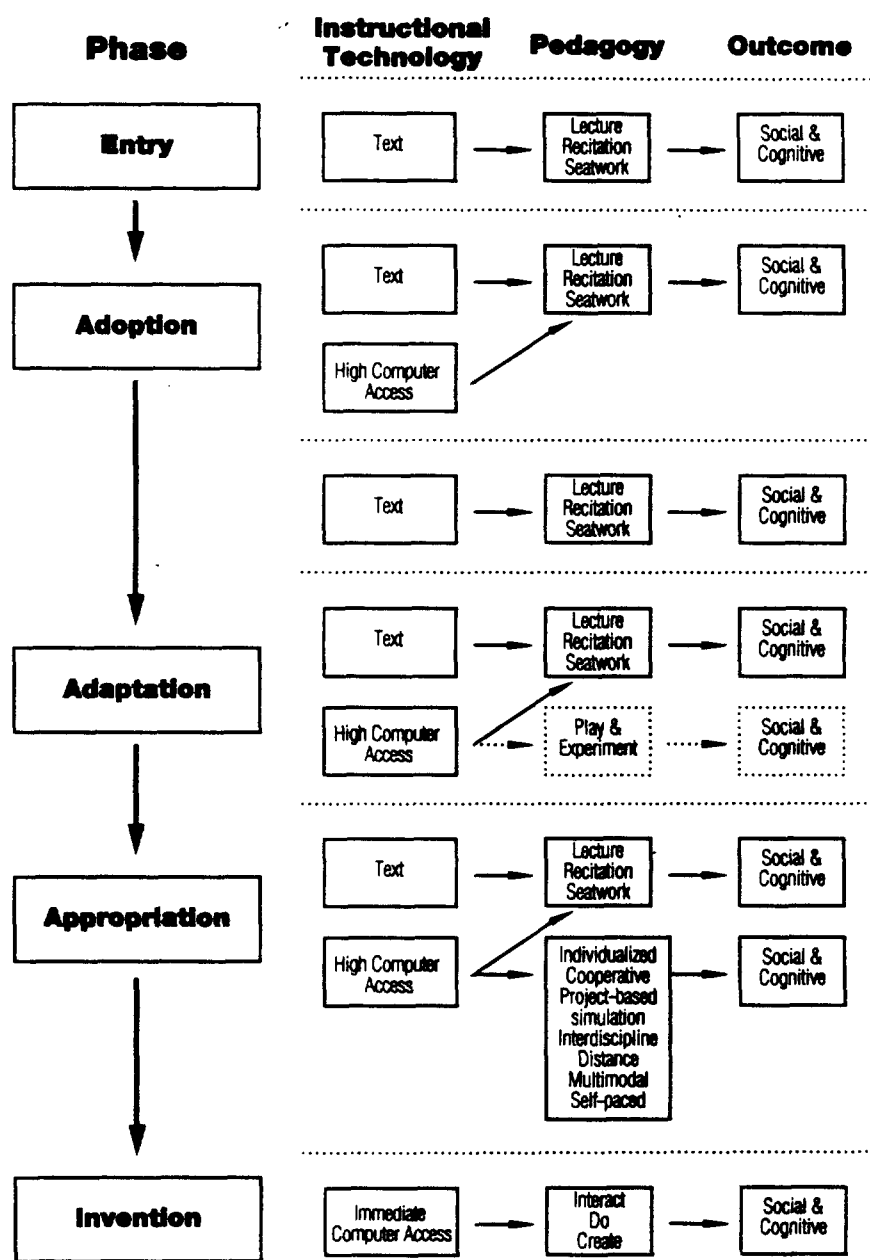


Figure 1: Instructional Evolution in Technology-Intensive Classrooms

Teacher interactions started shifting from offering technical help to sharing instruction strategies.

Collaboration on instruction emerged when teachers ventured beyond using the computer for drill-and-practice.

Feeling comfortable with increased interaction, teachers started to observe each other's teaching methods.

When teachers began using technology effortlessly as a tool, their roles shifted noticeably.

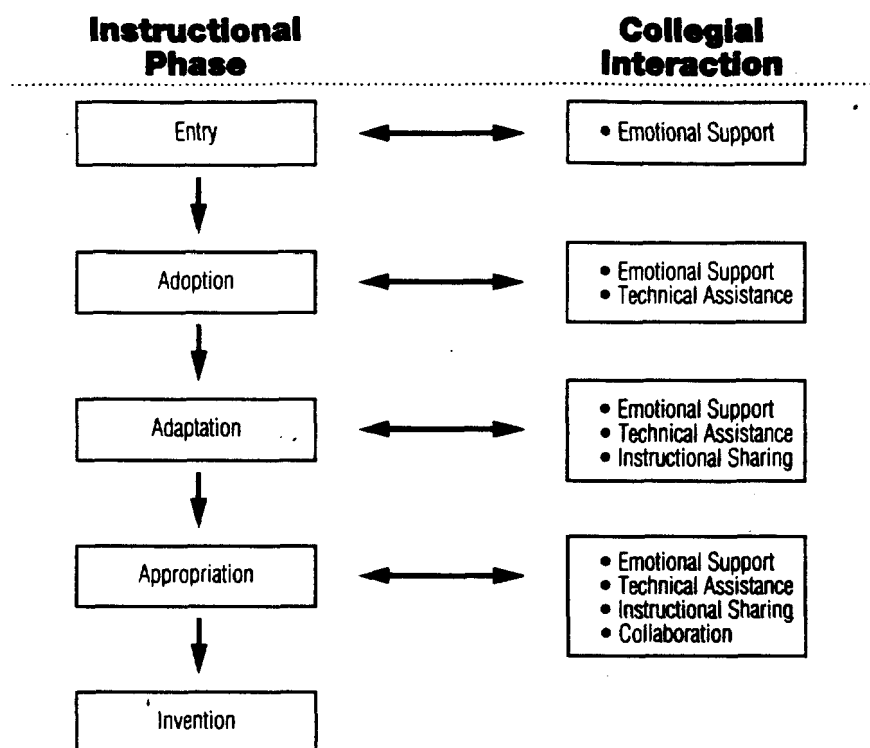


Figure 2: The relationship between Instructional Evolution and Collegial Interaction of Teachers

Figure 2 depicts the relationship between the instructional evolution and the collegial interaction of teachers. Corresponding to the gradual instructional shifts are changes in the frequency and form of collegial interaction. At the beginning of the project, interaction was infrequent and focused on emotional support. Over time, teachers' interactions shifted to include technical assistance, instructional-sharing, and, eventually, formalized collaboration.

### Categories of Collegial Interaction

Emotional Support	Sharing frustrations and successes, providing encouragement
Technical Assistance	Managing equipment, using equipment, locating software, using software, dealing with technical problems
Instructional Sharing	Discussing instructional strategies, sharing ideas, observing instruction
Collaboration	Joint planning, team teaching, developing new methods, interdisciplinary teaching

Table 2 summarizes the main differences among the categories of collegial interaction.

The following sections briefly summarize the changes in instructional practices during each stage, and describe the accompanying changes in collegial interaction among the teachers.

*New instructional patterns emerged.*

*Teachers began to reflect and question old patterns.*

*The most interaction occurred at schools where team teaching was formalized.*

*Team teaching created friction because of differences in personalities, technology know-how and teaching styles, including grading and discipline.*

**Instructional Activities** In the entry stage of the project, ACOT teachers had little or no experience with computer technology and demonstrated little inclination to significantly change their instruction. The first weeks of the project involved transforming the physical environment of the classroom — unpacking boxes, running extension cords, untangling cables, inserting cards, formatting disks, checking out home systems. Once instruction began, experienced teachers faced typical first-year-teacher problems such as discipline, resource management, and personal frustration. (See Sandholtz, Ringstaff, & Dwyer, 1990, for a full discussion of classroom management issues.) Teachers began using their technological resources, but simply to replicate traditional instructional and learning activities.

**Teacher Interaction** During these first few weeks, teachers had little time for collegial interaction even though the supports for such interaction, such as professional release time, training workshops, and a telecommunications network between sites, were available. As the year progressed, the frequency of interaction among teachers increased, but exchanges remained informal, and focused on emotional support, as teachers shared their frustrations and successes.

#### **Adoption: Technical Assistance**

**Instructional Activities** As teachers moved into the adoption stage, their concerns began to shift from connecting the computers to using them. Teachers adopted the new electronic technology to support established text-based drill-and-practice instruction. Students continued to receive steady diets of whole-group lectures, recitation, and individualized seat work. Although the physical environment had changed, the instructional strategies remained the same, just using different tools.

**Teacher Interaction** As teachers began to utilize the new technology in their instruction, their interactions increased but revolved around providing technical assistance. Teachers in project classrooms, both within and across sites, shared strategies in areas such as managing the equipment and locating relevant software.

Formal meetings among the project teachers at each site provided opportunities for sharing experiences and ideas. Teachers also began using the AppleLink telecommunications network to submit weekly reports and to communicate with teachers at other sites. Those with less computer expertise approached their colleagues for assistance and capitalized on opportunities to learn from each other.

*You've cleared up a lot of questions for me. I didn't know I could send anything but Microsoft Word over AppleLink...I'm still pretty new at this. (SL, 11/25/88)<sup>1</sup>*

*I found out that the kids had put their database information together, and I saw the same entries in my combined database. Unfortunately, I didn't know which student did what entries because I just dumped all of the files into my database. [Another teacher] told me how I can put the student's name in a column and then know what data belongs to what student. (AT, 2<sup>nd</sup> 46, 10/30/87)*

Technical assistance among the teachers helped them to adopt the new technology and to begin to utilize it in their instruction, even if simply as a support for their previous instructional style. Conversely, because the teachers began to accept the innovation, they had questions and concerns which compelled them to seek assistance from their colleagues.

<sup>1</sup> The initials following each transcription refer to the source material: "AT" for audio tape; "WL" for weekly link, the AppleLink reports each ACOT teacher submitted on a weekly basis; and "SL" for site link, a spontaneous message also sent via the AppleLink electronic network.

*While teachers agreed in principle during planning, their differences became obvious when they taught together.*

*Some enjoyed collaboration, while others were reluctant to lose autonomy.*

*Secondary teachers had a harder time making the transition to team teaching than elementary teachers because of a stronger sense of ownership of subject matter.*

## **Adaptation/Instructional Sharing**

**Instructional Activities** The adaptation phase brought changes in the efficiency of the instructional process. Students' productivity increased in a variety of areas. For example, students completed a self-paced math curriculum in significantly less time than usual, allowing teachers to engage students in higher-order learning objectives and problem solving. Many students also completed written assignments more quickly, with greater fluency, and willingly reworked their papers. According to one study, students not only produced more written work but the quality improved as a result of computer accessibility (Hiebert, 1987).

**Teacher Interaction** During this phase, teacher interactions began to shift from offering technical assistance to sharing instructional strategies. Collaboration on instructional topics emerged when teachers ventured beyond text-based drill-and-practice, and experimentation with new applications motivated them to share their endeavors with other teachers and sites.

*The kids are transposing their music into Logowriter language using sub and super procedures. We then got into doing shapes which resulted in animation. We're using Turtle Graphics for graphics and animation, also including sound effects. The kids love it; they worked solidly at it. It was amazing what they all came up with; they work in cooperative groups so no one gets left out. I'd like to share this with [another] site that has a sixth grade. I'd like to get more communication between the two. (AT, 3432, 2/15/88)*

Teachers continued to communicate directly to other ACOT colleagues through the network, and offered unsolicited assistance in response to weekly reports published on the network. At several sites, teachers decided that the benefits of cross-site communication should be extended to the students as well, and they arranged for specific days when the students in their classes could "chat" using telecommunications. Others set up formalized "AppleLink pals" arrangements that lasted throughout the school year. Students not only sent electronic mail, but also videotapes so the AppleLink pals could see each other in the classroom setting. One teacher arranged for students to correspond with students in Sweden, leading teachers at other sites to request similar opportunities for their classes.

As teachers began to feel comfortable with increased interaction among both students and teachers, they started to observe each other's teaching methods, as opposed to simply discussing their instructional ideas. Previously, very few teachers had observed other classrooms, and when they did, the primary purpose was to learn more about the technology rather than to garner instructional ideas.

*I realized after this conference that I need to share with the other math teachers what we are doing with the graphic calculator and to extend the program to more than the ACOT classes. (AT, 5863, 12/11/88)*

## **Appropriation: Collaboration**

**Instructional Activities** As teachers eventually reached the Appropriation phase — the point at which an individual comes to understand technology and use it effortlessly as a tool to accomplish real work — their roles began to shift noticeably and new instructional patterns emerged. Team teaching, interdisciplinary project-based instruction, and individually-paced instruction became more common at all of the sites. To accommodate more ambitious class projects, some teachers even altered the master schedule. Perhaps most important in this phase was an increasing tendency among ACOT teachers to reflect on teaching, to question old patterns, and to speculate about the causes behind changes they were seeing in their students.

*Obstacles were overcome by arranging time to do cooperative planning and locating offices near classrooms so teachers had more contact with each other.*

*Teachers learned how to effectively prioritize, set goals and create lessons so colleagues understood what needed to be done.*

*Successful teams resolved personality and teaching style differences.*

*Teacher Interaction* Along with the new instructional patterns came increased collaboration on instructional topics. The greatest degree of interaction occurred at sites that decided to formalize team teaching arrangements, a decision which was made by the teachers themselves rather than being imposed by district or school administrators. Given the differences at each site, team teaching configurations varied in the number of team members, student groupings, interdisciplinary approaches, and grade level assignments. As the benefits of team teaching became more apparent, ACOT staff encouraged this arrangement at all of the sites.

In the beginning, teachers frequently viewed team teaching as a great deal of additional work for relatively little gain. Some of the primary obstacles included differences in personalities, technical knowledge, teaching styles, grading policies, and approaches to discipline. For some teams, personality differences created only minor problems as the teachers came to know each other better. However, other teams found that personality problems carried over from year to year and became extremely divisive.

*[One teacher] is not an easy person to talk with — he is always sure what he is doing is right. I'm not really sure what my role is sometimes. . . so we need to work this out. I wonder if the other sites have these personality problems? (AT, 7127, 9/27/88)*

*I must say that the team teaching approach seems to create some friction; jealousies seem to arise when one teacher thinks another teacher is doing something that makes him or her look good and the other teacher look bad. I think it is unfortunate. We should dismiss our personalities and subjective feelings about things and get on with teaching. If we let students and their learning come first, everything else would fall into place. (AT, 7539, 12/13/88)*

Differences in technical knowledge among teachers also led to conflicts and feelings of competition.

*As things become more competitive in terms of the use of equipment and software, and as some of us have become more competent, some of those who have been the "kings" have been challenged and are reacting in unfortunate ways which is creating some tensions. (AT, 610, 11/17/89)*

Teachers found it easy to agree in principle as they planned collaborations. However, when they began teaching together, differences became more obvious. One such difference was teaching style. One team teacher believed in allowing students enough time to finish an assignment, while the other stuck to a pre-determined time schedule. Another team discovered they held divergent views about the structure of mathematics and their approaches to answering students' questions.

*I'm also trying to impress on him that math is not just the calculating in the problems he gives. The thinking process of setting it up is math, too. (AT, 412, 4/27/90)*

*He answered a lot of questions for the students. The only problem is he'll sit down and do it, not tell them how to do it. (AT, 458, 5/16/90)*

Like many teachers, ACOT teachers felt strongly about their teaching philosophies and styles. Consequently, they were resistant to changing their own style and were hesitant to impose their technique on other teachers. While some teachers enjoyed working closely with colleagues, others were reluctant to relinquish their autonomy.

*Varying teaching approaches could be complementary and beneficial to student learning.*

*Team teaching gave more flexibility in grouping students and made it easier to spot students' misunderstandings.*

*The team approach allowed one teacher to be absent without throwing instruction off schedule.*

*Moving from an independent teacher to a team teacher without much preparation contributed a great deal to my feelings of aimlessness and lack of control. It worked but I was uncomfortable with it. I feel better about being in charge of teaching and the curriculum. (AT, 6052, 12/11/86)*

Some found they were defining their team teaching roles differently. One teacher felt it was okay to work on individual projects or to leave the room when the other person was "teaching." The other teacher felt a team approach involved more than a simple division of responsibilities.

*Those opportunities to fit things together don't come up unless you're right there in the classroom paying attention. He feels if I'm teaching there's no need for him to be there. (AT, 220, 10/27/89)*

Inevitable differences in discipline and grading policies created initial obstacles to team teaching. Some teachers believed in making computerized summaries of scores and grades available to students while others felt such a policy created competition and emphasized grades over substantive learning. Teachers also expressed frustration over varying approaches to classroom management and discipline.

*I don't believe that her standards of discipline were the same as mine. She was very patient with the children and didn't use discipline techniques. Their behavior tended to get out of hand before she brought them back, which frustrated me. (AT, 1392, 6/13/90)*

Elementary teachers tended to exhibit less ownership over subject matter and frequently had prior experience working together. At the secondary school level, teams had to break through the boundaries of established subject matter, and overcome the independent orientation of the teachers. Team teaching also requires planning time during the school day, but elementary school teachers typically do not have a daily preparation period, making it difficult to set up a common planning time. In addition, a school's physical layout sometimes hinders the opportunity for spontaneous interaction and cooperative planning. While some teams were able to overcome the obstacles inherent in team teaching, others eventually reduced the amount of team teaching or dropped the arrangement altogether.

*I really feel better about being solely in charge of my own classes. Now when I come in at off hours to work I know that I'm working for myself. You just don't feel the same when it's a team. I need to feel that student performance results directly from my teaching. (AT, 6057, 12/11/86)*

The sites that continued with team teaching found various ways to overcome the obstacles. Proximity between classrooms and offices facilitated greater contact among teachers. Cooperative planning was facilitated by allowing teachers regularly scheduled time during the school day for meetings.

*The fact that we can sit down, coordinate lessons, and get a chance to talk is a very important thing to what it is we are trying to do out here. I need to campaign that all teachers should have that time to coordinate with a team teacher and how important that is to the learning process. (AT, 1143, 11/9/89)*

Teachers also became more proficient at using available time for planning. They learned how to prioritize, set goals and block out lessons so both team members understood what needed to be done. Having the time to plan eased tensions.

Successful teams also resolved personality differences and reached consensus about individual teaching styles, discipline policies, and the definition of team teaching. Although

*Cross disciplinary teaching helped students understand how subjects are integrated in the real world.*

*Students taught by teams could handle more advanced material than students in traditional classes.*

*The ACOT team teaching and interdisciplinary approach became a model for both schools and districts.*

problems reappeared periodically, these teams managed to reduce competition, and draw upon one another's areas of expertise and specialized knowledge. Those teachers who continued with team teaching began to reap the rewards of collaboration. They developed a strong camaraderie and gleaned support from one another.

*It is so nice, when you are having a stressful day, to have someone thinking about your needs. In a normal teaching situation, no one would even know what your needs are. (AT, 100, 8/29/89)*

Teachers discovered ways to connect and improve upon activities and strategies they had tried individually, and found that their varying approaches could be complementary, and benefit rather than hinder student learning.

*[The other team member] was telling me that she was really impressed with the different way I covered the use of the trig functions today and how well that complemented what she had done. She thought the kids would come away with a better understanding. (AT, 1139, 11/7/89)*

The team approach also allowed more flexibility in grouping students. For example, one teacher could take small groups to the biology lab while the other remained in the classroom, decreasing the amount of lab equipment needed and making it easier to monitor students and answer questions. Other teachers tried a similar strategy with the chemistry class. Within the classroom, teachers could work with smaller groups requiring help in particular areas, and vary their teaching assignments for different groups.

*I am pleased with the way Algebra I has turned out. We have the students working in two groups, and we switched groups this week. She was getting frustrated with the group she had that just didn't follow through. So it was a good idea just to shift to keep from getting burned out on one group. This wouldn't have happened in a regular classroom. (AT, 771, 2/28/89)*

The teachers also reported that teaming increased what teachers were able to accomplish during a class period and made it easier to spot patterns of student misunderstanding.

*We had two pages of requests for individual attention on our sign-up list. That's 60 questions out of a class of 30 kids. There is no way you could do that in a period with one teacher. (AT, 3659, 11/4/88)*

When a team member was absent, the instructional program continued on schedule — unlike what occurred previously with substitute teachers. Teachers felt more comfortable about attending professional conferences scheduled during the school year.

The team teaching arrangement allowed teachers at all grade levels to develop and implement interdisciplinary curriculum across a variety of subject areas such as math/science, life skills/English, history/literature. Teachers also combined a number of subject areas into one class; for example, a class called "Strategies" included math computation, problem-solving, science, and health. Through cross-disciplinary teaching, students started to understand the integration among subject areas, instead of viewing them as separate, unrelated subjects.

*The students don't differentiate between math and science now. It is exciting to have an opportunity to work in an interdisciplinary way. (AT, 240, 11/14/89)*

*Using technology drove teachers to be more collegial and share instruction.*

*Teachers who already enjoyed a high level of collegiality embraced innovation in technology and instruction more quickly.*

*The view that team teaching is more demanding than beneficial changed.*

*Team teaching led to cross disciplinary instruction benefiting students and teachers.*

*In the course we are teaching — American literature and history together— the students are really putting the two together . . . It will help them learn two areas which in the past students thought were boring. Now they are thinking and asking questions about it. (AT, 1, 10/7/88)*

Teachers discovered that their team-taught classes could handle more advanced material than students in traditional classes.

*[One teacher] sees a great difference in the amount of understanding the ACOT students have as compared with the students in his two regular classes that do not have the luxury of the teaming approach with the mathematics teacher. (WL, 10190, 12/12/86)*

A math/science team found they were teaching concepts that other science teachers avoided because they believed the students couldn't do the math involved. The integration also helped the math/science teams in their goal of helping students to develop problem solving skills in mathematics rather than simply seeking solutions.

*In the past, students have had a hard time determining which trig function to use to solve the triangle, no matter how much we go over it. Now they see it in math and physics classes. (AT, 236, 11/8/89)*

The teachers noted an increase in their own enthusiasm and knowledge as they became involved in interdisciplinary teaching. At the secondary level, the boundaries between subjects started to diminish, and teachers began to seek out instructional resources and opportunities in other subject areas.

*Team teaching is interesting because I concentrate on math, but I try to think of the science applications of it. I look for more ideas and materials than I would as a solitary teacher. (AT, 238, 11/10/89)*

At one site, the team teaching and interdisciplinary approach developed by the project teachers became a model for classes throughout the school and district. A principal at another high school in the district, highly impressed with the approach, located funding to modify the model and develop curriculum that could be replicated in other urban schools — even those without access to technology.

This study points out the symbiotic relationship between innovation and collegial interaction. The innovative, high-access-to-technology classrooms drove teachers to more collegial interaction and instructional sharing. But teachers who already enjoyed a high level of collegial interaction embraced technological innovation and implemented new instructional strategies more quickly.

The instructional changes among the teachers corresponded closely with changes in collegial interaction. In the entry stage of the project, the teachers demonstrated little penchant for significant instructional change, and their collegial interaction was infrequent and focused on emotional support. In the adoption stage, teachers used the technology to support traditional instructional and learning activities; collegial interaction increased but included primarily technical assistance. The adaptation phase brought changes in the efficiency of the instructional process, and the substance of their interactions included the sharing of instructional strategies. As teachers eventually reached the appropriation phase, their roles shifted and new instructional patterns emerged. Similarly, teachers engaged in greater collaboration about instructional topics. At many sites, the increased collaboration led to team teaching and interdisciplinary instruction.

*Change happens fastest when innovation and collegial interaction happen simultaneously.*

*Significant change won't occur simply by giving teachers computers.*

*Innovations introduced at one level are likely to fail. Innovations must be systemwide and simultaneous.*

At first, teachers viewed team teaching as more demanding than beneficial. But as sites continued with team teaching and found ways to overcome the inherent obstacles, the benefits began to emerge. Eventually, team teaching led to cross-disciplinary teaching which held additional advantages for both teachers and students.

### **Advantages of team teaching**

- Shared responsibilities
- Increased camaraderie, enthusiasm and support
- Development of activities based on teacher strengths
- Development of new ideas and teaching methods
- Utilization of approaches that promote student understanding
- Increased individual help for students
- Increased flexibility in grouping students
- Increased amount accomplished during class period
- Greater ease in identifying student misunderstanding
- Continuity of instructional program when one teacher is absent
- Development of an interdisciplinary curriculum
- Greater student ability to handle more advanced material

Table 3

This paper highlights four main issues relevant to practice and research. First, the adoption of innovation and the creation of a collaborative environment are complementary conditions for change. Individuals interested in school change need not focus only on one condition. Change occurs most quickly in environments where innovation and collegial interaction are operating simultaneously, each enhancing the other.

Second, in line with the beliefs of those attempting to restructure schools (David, 1990; David, Cohen, Honetschlager, & Traidman, 1990), our reflections on the ACOT experience support the idea that structural and programmatic shifts in the working environments of teachers who are adopting innovative technology are critical. The nationwide movement toward restructuring the entire school system—including the curriculum, the way students are taught, and the way schools are governed—seeks to attack the problem of change from multiple levels simultaneously. Unlike previous reform efforts, the reconstruction movement acknowledges that innovations introduced at only one level of the system are not likely to succeed.

Lasting, significant change will not occur simply by giving teachers the latest technological tools. Rather, teachers must be provided with on-going support which is available only if the larger system in which they are working changes as well. Organizational supports for ACOT teachers included training workshops, technical support, release time for conferences, extra time for joint planning and team teaching, a telecommunications network that allowed interaction across sites and with the ACOT project staff, and the opportunity for routine peer observations and group discussions. One site was even allowed by the school and district to alter the master schedule.

Third, not only can restructuring enhance the adoption and integration of technology—or any innovation, for that matter—but the introduction of technology to schools can act as a catalyst for change, thereby enhancing restructuring efforts.

In the case of ACOT, the introduction of technology had a direct impact on the way teachers worked with one another: there was more emotional support, more sharing of instructional ideas, and more collegial interaction because teachers sought each other out in their attempts to adapt to their innovative classrooms. Perhaps, in the scheme of things, this

*The introduction of technology can be a catalyst for change.*

*Change is slow, so schools must take a long-term perspective.*

*Teachers won't commit to innovation until it makes a positive impact on their practice.*

is a relatively small change, but the reduction of teacher isolation is an important part of restructuring.

Finally, the experience of the ACOT project demonstrates the value of taking a long-term perspective on change. Data from this five-year study illustrate that, even when classroom environments are drastically altered and teachers are willingly immersed in innovation, change is slow, and sometimes includes temporary regression. Unfortunately, agencies or organizations funding innovative programs often expect to see measurable progress or change within a short time. In line with other research on teacher change, the data suggest that teacher commitment to an innovation will not occur until they see a positive impact on their teaching. Moreover, those searching for a way to assess the impact of innovation should not expect to see a clear progression through stages. Problems of implementation and adoption may arise, disappear, and then reoccur as teachers and students adjust to the innovation.

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## Footnote

<sup>1</sup> The data notation system used throughout this paper indicates the source of the data (AT = audio tape data; WL = weekly reports sent via electronic mail; SL = links sent between sites), the episode's entry number in the database, and when the data were generated.

This report is a summary of a paper presented at the annual meeting of the American Education Research Association in 1991. Editors for ACOT were Jenny Abbe and Mary A. C. Fallon.

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## APPLE CLASSROOMS OF TOMORROW

**The Negotiations of Group  
Authorship Among Second  
Graders Using Multimedia  
Composing Software**

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**ACOT Report #14**

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# Research

## The Study

*This study focuses on five 2nd graders creating a multimedia presentation with 'StoryShow,' a software application for combining images, sound and text.*

*Each task performed was essential but the director's role became pivotal to completion of the assignment.*

*Technology changes the kinds of text children interact with and the kinds of interactions children have with text when it is widely used in reading and writing.*

*Research literature shows that technology is interpreted according to the relationships that already existed among teachers and students before technology was introduced.*

Begin in 1985, Apple Classrooms of Tomorrow (ACOT)<sup>SM</sup> is a research and development collaboration among public schools, universities, research agencies and Apple Computer, Inc. ACOT explores, develops and demonstrates the powerful uses of technologies in teaching and learning. In all ACOT endeavors, instruction and assessment are as integral to learning as technology.

Supporting a constructivist approach to learning, technology is used as knowledge-building tools. As students collaborate, create media-rich compositions and use simulations and models, researchers investigate four aspects of learning: tasks, interactions, situations and tools. The research is formative. The findings guide ACOT staff and teachers as they refine their approach to learning, teaching and professional development. ACOT teachers and students often use the most advanced technologies available, including experimental technologies, to help us envision the future and improve the educational process.

ACOT views technology as a necessary and catalytic part of the effort required to fundamentally restructure America's education system. We hope that by sharing our results with parents, educators, policy makers, and technology developers the lessons of ACOT will contribute to the advancement of educational reform.

### Abstract

Beginning with a review of relevant literature on learning and computers, this report focuses on a group of five second graders in the process of creating a multimedia presentation for their class. Using software that combines images, sound and text, the students took on a variety of production roles. Each one contributed at least one image and sound element to the final composition. Each task the students performed—manipulating hardware or software, choosing images from books or directing other students—was essential to the overall success of the composition, but the role of director, taken on by one girl in the group, became the key to its completion.

The success of this episode was facilitated, in part, by the teacher's interpretation of how the software might be used, and a classroom environment that supported the kinds of independent and collaborative activities that the software encouraged.

### Introduction

According to Vygotsky (1978), the tools that we use to manipulate signs—in the form of language or other symbol systems—mediate our interactions with the world and restructure our mental activity. In human societies, people perform numerous tasks with the aid of tools as simple as hammers and saws or as complex as writing systems. As people use these tools, they bring changes to both the world around them and to the psychological processes and representations that underlie the activities (Vygotsky, 1978; Martin & Scribner, 1988).

Technology—when widely used for children's reading and writing activities—is changing the kinds of interactions children have with text, as well as the kinds of texts with which they interact. New computer-based tools combine text, sound, image and video in various ways—as in videodiscs and video games—providing new methods for creating texts. In this report, we see how a multimedia composition tool designed specifically for children was used by a group of five students in a second grade classroom.

*How each individual child uses a computer will always be closely connected to the social relationships existing in the classroom.*

*Children who play video games and watch television, have an intertextual world that stretches beyond the book, to include particular characters and stories as well as particular ways of interacting with texts.*

*Collaborative tools can help people produce something together that no one person could produce working alone.*

*How tools are designed will influence the ways students can collaborate.*

Any technology is conceived, developed and employed in a particular social context, and the influence it has depends greatly upon how it is used in a given environment. Putting a computer in a classroom is not likely to lead to changes in learning unless the computer-based activities relate closely to the kinds of activities already taking place in that classroom.

In Mehan's (1989) study of the use of single microcomputers in four classrooms, he describes how the technology was used in very different ways by each teacher, leading to different changes in classroom activity. Mehan argues that the social structure of the classroom is the key element in understanding how technology will be used. Although particular uses of technology may encourage participation, the most important factor is not the computer and the software, but what is done with them.

Similar conclusions are drawn by Hawkins (1987) in an analysis of Logo use by teachers and students, by Genishi (1988) who examined the use of Logo in a kindergarten classroom, and by Cochran-Smith (1991) in a review of word processing research with children. This research supports the assertion that technology is interpreted according to the relationships that exist in the classroom prior to the presence of the technology.

### **Writing and Technology**

Most research on writing with computers has concentrated on cognitive processes in isolation from particular writing contexts (Cochran-Smith, Paris & Kahn, 1991), while research on reading and technology has focussed on Computer-Assisted Instruction, such as reading improvement software (Balajthy, 1989). Neither of these approaches seems adequate when attempting to explain how a particular technology is integrated into the culture of a classroom. The kinds of changes that may occur are not likely to be captured if the focus of research is only on individuals and does not attempt to understand the classroom environment. The manner in which an individual child makes use of a computer will always be closely connected to the presence of other children and teachers, for it is the social relationships which exist in the classroom that will help us understand how and why things happen, whether or not they involve technology.

As Cochran-Smith et al. (1991) state in their study of word processing and elementary students:

*Learning to write with computers and learning to teach writing with computers are qualitatively different experiences from learning with pencil and paper. (p. 1)*

According to Cochran-Smith, word processing can lead to the use of new social arrangements involving collaboration and coaching, which in turn shape the theories and practices of writing in the classroom. Although there is little evidence that the quality of student writing changes when word processors are available, their study indicates that children may spend more time writing, and produce texts that are slightly longer than those created using pen and paper. What is not clear from the study is whether students who have continuous access to computers use them differently than students who may use computers once a week in a computer lab, or who have a single computer available in their classroom.

### **Literacy**

Lemke (1989) has described literacy as knowledge about a world of texts, and making connections between them, both to understand and to be understood. Schooling can be seen as learning to master texts deemed important by a particular society. Barthes (1974) views text as just a set of potential meanings which are only realized through the reader-text interaction. This interaction is complex and greatly influenced, as Lemke notes, by other text with which a reader is familiar. For children accustomed to video games and television, their intertextual world stretches beyond the book to include particular characters and stories as

*The opportunity to record and analyze the public thoughts and writing activities of students is an advantage brought on by collaborative writing.*

*Tools facilitating collaborative composing could be improved if designers understand what kinds of collaborations are valuable and how software design relates to use.*

*StoryShow was conceived to help children construct stories that incorporate images and written and oral language. However this study indicates that is not necessarily how the software will be used.*

*The software used a slide show metaphor. Each slide can consist of an image, text and sounds.*

well as particular ways of interacting with texts.

Barthes differentiates between "readerly" and "writerly texts". The writerly text gives the reader more room to maneuver, and the reader is more actively involved in creating meaning. With readerly text, in contrast, the reader is left to accept or reject what is presented, and meaning is often overly-determined by the writer.

This distribution of power and control between text and reader, and the role it plays in how meaning is arrived at, seems a key point in understanding the reading and writing of children who are accustomed to different kinds of texts, such as video games, which may be seen as very "writerly." A child interacting with a video game has a large amount of control over what happens as the game progresses. When the same children create or read text, similar options may not always be available. When they are, as in the case of multimedia technologies and computers, children may find the kinds of interactions possible a more natural extension of video games than books or other activities available to them.

### Computer Supported Cooperative Work

In a review of tools for collaboration, Michael Schrage (1990) makes a distinction between increasing communication and increasing collaboration, and emphasizes that different tools are needed for collaboration. Schrage defines collaboration as shared discovery or shared creation, and shows that the need for collaboration is great when people deal with complex problems or when people with different areas of expertise need to work together. Collaborative tools can help people produce something together that no one person could produce working alone.

How tools are designed will influence the kinds of collaboration they encourage. The desk, according to Schrage, is designed for the individual working alone. The same could be said for most computer software, which usually assumes one user with one keyboard and one mouse working on one computer. Tools for collaboration can help people develop what Schrage calls a "shared space." The shared space can be generated by people separated by time and distance, but it is through the use of the shared space that a collaboration will be shaped. Language is the primary way in which this shared understanding is developed, for as Schrage points out, language is the primary tool for collaboration.

While not primarily focused on the collaborative aspects of software design, several studies of word processing among children have considered how the use of computers for writing encourages collaborative writing. Heap (1989) points out that collaborative activity makes private cognitive processes public — students have to negotiate the use of the computer, and development of a text, through language. For research purposes, the opportunity to record and analyze the public thoughts and writing activities of students is an advantage brought on by collaborative writing. Dickinson's study (1986) on the use of a computer for writing in a first-second grade classroom focussed on the social structure that arose as the computer was used, and examined the planning, self-monitoring and response to writing that occurred as a result. In this case the computer was integrated into the pre-existing writing curriculum and treated as another tool for writing by the teacher, but its use led to more opportunities for children to talk among themselves than was possible when they wrote with pencil and paper. Both Dickinson and Heap looked at classrooms with one computer, and with word processing software designed with a single user in mind. In both cases, the cooperative aspects of composing are defined socially, and are not primary features of the writing tools in use. Students collaborated because they chose to work together and because there was a shortage of tools.

Neither of these studies provides a definition of collaborative text. Is a story written by one child with help from a computer assistant collaborative in the same way that a story jointly composed by two students is? Certainly collaboration in writing can exist at a number of levels, but if better tools to facilitate collaborative composing are to be designed, there needs to be an understanding of what kinds of collaboration are valuable, and how software/tool

*This analysis discusses how students allocated composing tasks and how the social interactions that occurred when the software was used fit into the class' overall social structure. It also discusses the relationship between software design, intended use and actual use.*

*Students weren't assigned specific tasks by the teacher.*

*Multiple technologies in the room allowed each students to play several roles.*

*Donnie controlled the mouse pointing device for most events during the composing process. However, technical control didn't translate into content control.*

design relates to use in classrooms.

In this report we examine the use of *StoryShow*, a multimedia composing tool conceived to help young children construct stories that incorporate images, and written and oral language. It was designed for use by two students, although in this case it involved more, with particular features designed to encourage collaborative composing, editing, and the sharing of tasks. The primary questions for this study are:

- How does each child get to play the role of author?
- How does the sharing of tasks reflect the social structure already existing in the classroom?
- How does the intended use of the software differ from how it is actually used in the classroom?

The research method employed in this study is micro-ethnographic. The overall goal of the larger ACOT study, of which this report is one part, is to understand classroom learning activities from the point of view of the participants, to describe how innovative educational tools move from design to actual use, and to show how that knowledge may be applied to future designs.

This study took place in a second grade classroom in the Silicon Valley area of California as part of long-term research conducted by the Apple Classrooms of Tomorrow project of Apple Computer, Inc. The second grade teacher chose to participate in the field-testing of *StoryShow*, which had previously been in use in the first and fourth grade classrooms of this ACOT school.

The teacher in this classroom, Ms. Boston, had been teaching for 29 years, including the previous three years as an ACOT teacher. She had become accustomed to teaching with technology, and had made some adjustments because of it, but she was not as eager to use new software and hardware as some other teachers in the school and preferred to have assistance when trying out new technologies.

The school population is drawn largely from middle to upper socio-economic families, with many parents taking a strong interest in their child's schooling. In Ms. Boston's class there were 27 students, approximately 70 percent Anglo and 30 percent Asian. The five students participating in this study were chosen by the teacher, and the activities were conducted during the natural course of events in the classroom.

The classroom itself was unique in terms of the amount of technology available to students and teacher: eight Macintosh® computers, three scanners, a laser printer, and a MacRecorder. In addition, there were 16 Apple II GS computers, eight dot-matrix printers and two video cassette recorders with color monitors. Another Macintosh, connected to a videodisc player, was shared with another classroom.

Students used the computers for writing in journals, composing stories or drawing or creating animation. Computers were not used for playing games in the classroom. Over the course of a day, students were likely to use a computer for a total of about one hour.

Reading and writing activities were integrated in Ms. Boston's classroom. Children often read a particular type of story as a group, an additional story on their own, then wrote their own story on the same topic. The open atmosphere in the classroom allowed students to move around relatively freely, so collaboration of various kinds was likely to take place throughout the day. Collaboration might involve one student assisting another with a computer task, or with spelling, or could be a group activity with students reading aloud or acting out parts of a story.

*Julie was recognized by the other students as the activity's leader and she dominated content.*

*Students turned to her for decision-making.*

*Rick controlled the microphone, even when it wasn't in use. However, microphone control had little impact on content or participation. When she needed it, Julie physically took control of the microphone from Rick.*

*The final slide show produced by the group is evidence of the cooperative nature of the composing process, but it masks the way students arrived at the final text.*

The primary activity observed and recorded in this study was the use of the multimedia composing software *StoryShow*, during one morning session in Ms. Boston's classroom. The software was developed at Apple Computer, Inc. for several months before it was introduced in classrooms. *StoryShow* was conceived to help children construct stories that incorporate images and written and oral language. As this study indicates, that is not necessarily how it will be used in classrooms.

*StoryShow* is presently designed to run on Macintosh computers with color monitors, integrating video capture, scanning, sound input, and text. The video, image scanning, and sound elements are provided through additional devices attached to the Macintosh — an 8 mm video camera connected to the Macintosh using a video capture board, an Apple flatbed scanner for images in books or drawn by hand on paper, and a MacRecorder for sound input. Each of these devices can be accessed directly from *StoryShow* via a mouse click.<sup>1</sup> The software uses the metaphor of a slide show, with each slide potentially consisting of an image, text, and sound. The resulting multimedia text can be played back on the screen as a series of images, sounds, and text, and it can be saved to a videotape which can then be replayed on a video cassette recorder at home or in school.

Initial testing was conducted informally on pairs of six and seven year old children. This was done early in the design and programming phase of the project to ensure the program was not too complex for the target audience. Additional testing continued with first and fourth graders in volunteer classrooms, and was ongoing during the time of this study.



*StoryShow uses a slide show metaphor to combine text, images and sound.*

The data for this study were collected over a five-week period and consisted of field notes from observations of classroom activity, videotapes of students working in the classroom and using *StoryShow*, a video taped trace of what students produced on the computer screen, the computer files of their work, and a taped interview with the teacher.

The students in Ms. Boston's class were initially introduced to *StoryShow* in a 60 minute demonstration. Several children participated directly, and the entire class chose pictures and sound that went into the final text. The following week a group of six children built a multimedia composition using *StoryShow*.

The students' next use of *StoryShow*, and the one reported in this study, occurred on a day when the classroom was being used as the background for a local television show about

<sup>1</sup> A "mouse," is an input device supplementary to a computer keyboard that facilitates the manipulation of text and images. The mouse includes a button, which when pressed or "clicked," causes an action to occur on the screen.

*Even in the cases where sounds or images were supplied by someone other than Julie, the "director," she often had the final say as to what image was used and which sounds accompanied which images.*

*The boys showed more interest in controlling the hardware than in actually choosing what went into the composition. Their language implied a link between device control and actual production that didn't exist.*

computers and education. Students were assigned to *StoryShow* to illustrate the kinds of activities students carried out with computers. Filming for the television show lasted about 35 minutes, with some disruptions, and *StoryShow* activity then continued for an additional 90 minutes.

The student work group consisted initially of two boys, Rick and Donnie, and two girls, Julie and Amber. A third girl, Mary, joined the group near the end of the activity. All students in this group are Anglo-American with the exception of Donnie, who is Asian-American.

During data collection I participated as a technical assistant to the children, correcting problems that came up during their use of the software. I tried to refrain from providing assistance on content questions entirely, and kept my technical help to the minimum necessary to allow the children to use the software.

The videotapes of children working at the computer and the trace of their interactions with the software were reviewed and categorized by the events, participant structures and content produced. I defined an event as bounded by the start of any activity designed to add a new element to the composition, and the completion or abandonment of that activity. I focused on who was operating each of the two main control devices (mouse, microphone), who provided the content during the given event, and who made the final decision on content for that event. For content, I considered the use of the three elements available in each slide — image, sound, and text.

The goal of this analysis was to understand how the students allocated composing tasks as they used the software, to understand how the social interactions that occurred while students used the software fit into the social structure of the classroom, and to consider the relationship between the design and intended use of the software, and how it was actually used by students.

### *Controlling Episodes*

Participant structures were examined in two ways — software control (use of the mouse), and content control (who selects what goes into the composition and who decides what actually gets saved as part of the final product.) The students were not assigned specific tasks by the teacher, but the presence of multiple technologies allowed each of the students to play various roles. In this case, both boys gravitated towards the computer while one of the girls, Julie, took control of the content.

Donnie controlled the mouse during 37 of the 44 total events I identified in the composing process, but this technical control did not translate into control over content or turn-taking. Content was dominated by Julie, who initiated actions that started 18 new events, and decided whether or not a particular sound or image would be saved for 38 of the 44 events (often sharing the decision with others.) Julie was recognized by the other students as the leader of this activity, as they often turned to her when a decision had to be made. This was consistent with other activities in the classroom, and Julie's skill as a leader was noted by Ms. Boston both during the time the group worked with *StoryShow* and in an interview. During most of the composing process, Rick maintained control of the microphone, even when it was not in use. Control of the microphone had little impact on content or participation, and when she needed it, Julie physically took control of the microphone from Rick.

The final slide show produced by the group gives evidence of the cooperative nature of the composing process, but through the presence of multiple authors, it tends to mask the way in which students arrived at the final text.

*As students progressed through the composition, more and more time was spent pre-editing. Images and sounds were rehearsed and oriented carefully before recording or capturing.*

*Colored icons represented actions controlling the software. In conversations, students referred more to the colors than the actions.*

*While composing with StoryShow was clearly an extension of the usual reading and writing activities, it also required students to manage a variety of new roles.*

Even in the cases where sound or image input was supplied by someone other than Julie, she often had the final say as to what image was used or what sound went with the image. For Mary and Rick, Julie provided assistance in selecting an image and coached them on the exact content of their sounds by speaking the words herself and having the other child repeat them before attempting to record the final sound. While this might seem an act of dominating the content, in each case, Rick and Mary were not quite sure what to say or what to put in, and Julie's actions could be seen as those of a more able peer providing the scaffolding necessary for the other children to successfully complete the task.

The following example illustrates the composing process used by this group. (In each of this example, I am identified as the "Assistant"). In the first example we see how the students have structured the process themselves. They have chosen to create a series of slides using books about rabbits they have read in class.

Speaker	What is said	Related Actions
Donnie:	Come on get some pictures. Where's the books?	Donnie using mouse
<i>Julie and Amber get books and hold them in front of the camera</i>		
Julie:	There it is. I want to hold it up (To Amber).	Julie takes book
Assistant:	What do you guys want to do?	
Julie:	Do the many rabbit stories of Mrs. Boston's class.	Julie sets book down
Donnie:	Get closer, get close.	
Julie:	No, why don't we hold up, why don't we hold up all of the books in front of the camera?	Julie backs away from camera
Julie:	(To Rick and Donnie) OK you guys grab a book.	
Donnie:	I'm not, I'm taking pictures. mouse	Donnie still controls
Julie:	Grab a book! (emphatically)	Amber gets a book
Rick:	And I am making sounds	

Both boys here show more interest in having control of the hardware than in actually choosing what goes into the composition. Their language — "I'm taking pictures," and "I am making sounds" imply a link between control of the devices to create the pictures and sounds and the actual production ("making") of them that didn't really exist. ('Mrs. Ellis' is the school's computer coordinator).

Speaker	What is said	Related Actions
Julie:	Grab two if you want to.	
Julie:	(To Rick and Donnie) Here, take two.	Julie hands them books
Julie:	Let's all get in front of the picture. All of these in front.	

Everyone holds up books. Julie has organized the group to take the picture.

*Taking a picture involved positioning a selected image in front of a video camera and pointing to the correct icon on the computer screen. The software froze the image momentarily giving students an opportunity to quickly evaluate it.*

*The software was designed to save images automatically, but offered a choice of saving or re-recording sound.*

*Image editing generally took place before it was captured. Images once in the computer were rarely rejected or re-taken.*

Speaker	What is said	Related Actions
Julie:	Uh oh, I have three.	
Rick:	Let's call this the introduction.	
Julie:	Hey no you guys...(unintelligible)	
<i>Rick and Donnie are holding their books up and they are blocking everything else</i>		
Julie and Amber:	Rick!	
Julie:	Can you hold this one?	
Rick:	It won't get, it won't fit.	
Julie:	Well, we all put in.	Donnie stands up.
Julie:	Donnie, your face is in the way. (laughing)	
Julie:	Donnie, put the other one, the Peter Rabbit book in the front.	
Donnie:	How am I gonna take a picture though?	
Julie:	Let me see?	
Assistant:	Who's gonna click the mouse?	
Donnie:	I will.	
Julie:	Mrs. Ellis.	Julie leaves
Julie:	Mrs. Ellis, could you, could you, could you?	Points to computer
Rick:	All right, do it.	
Julie:	Donnie, put up both of them, Mrs. Ellis's gonna do it.	
Donnie:	I can hardly do this.	
Julie:	Donnie, put up both of them. Put 'em together.	
David:	Ah, what's this? This is crazy	David wanders over

David was not part of the group but happened to walk over to that part of the classroom as they were working.

Speaker	What is said	Related Actions
Julie:	Are they both in the picture?	
Rick:	No.	
Mrs. Ellis:	There.	Standing next to computer
Donnie:	Take a picture.	
Mrs. Ellis:	Ready?	
Julie:	No, wait. Can you see all the books?	

However, sounds recorded for each slide were more often rejected and re-recorded. For the final slide, students recorded the sound six times before saving it.

Over the years, the teacher changed her teaching style to better suit her students, who commonly use interactive technologies such as video games and computers as well as the visually compelling medium—television.

Using as many different teaching methods became important to the teacher because one child might tune out sound but respond well to visual information, while another has the opposite reaction.

This is an example of the sort of attention to content and editing that took place, primarily as initiated by Julie, during the composing process. As they progressed through the composition, more and more time was spent pre-editing, that is, images and sounds were rehearsed or oriented carefully before recording or capturing.

Speaker	What is said	Related Actions
Assistant:	Now click on the face, the face.	
Mrs. Ellis:	Where's the mouse? What face, which face?	Couldn't find cursor
Assistant:	On the yellow.	
Donnie:	This one. (points to yellow icon of a face)	
Mrs Ellis:	OK on the yellow. Got it.	

The students referred more to the colors of objects on the screen than to the icons which represented the actions that would be initiated by clicking those objects with the mouse.

Speaker	What is said	Related Actions
Mrs. Ellis:	Ready? Tell me when?	
Julie:	No, we don't have all the books in.	
Mrs. Ellis:	There...now. Go.	Makes adjustments w/books
Picture is taken and appears on the screen after about five seconds		
Donnie:	Do you like that?	Using mouse
All:	Yeah!	

While composing with *StoryShow* can be seen clearly as an extension of the reading and writing activities usually carried out in class — reading stories and then writing about them or creating original stories on the same topic — it also required that students manage a variety of new roles. Julie initiated the event by distributing books and positioning the other students in front of the camera, and it was her idea to show several books in the picture as a way to capture what this composition was about — “The Many Rabbit Stories of Mrs. Boston’s Class.” However, the successful completion of the image required the cooperation of each student as well as the assistance of the school computer coordinator (Mrs. Ellis) who was in the room to help with the film crew. The process of taking the picture involved selecting an image, framing it by arranging people and objects in front of the camera, then capturing the image by clicking the mouse on the appropriate button on the screen. At this point the captured image froze momentarily on the screen, where it could be evaluated by the students. For each slide in this example, what might be described as editing of a slide took place before the image was captured. Once an image had been put into the computer, it was usually saved as-is and rarely rejected or retaken. Sounds recorded for each slide in the show were more often rejected and re-recorded.

It is interesting to note that the way sounds and images were designed to be processed by the software, paralleled their use by the students. Recorded sounds were immediately played back by the computer, giving students the choice of saving or re-recording the sounds. For the final slide in this example, students recorded the sound six times before saving it. The software originally worked the same way for sound or images: once recorded or

*Julie began the practice of discussing the sound first, then practicing it before attempting to record it. Immediate feedback from the computer seemed to make sound editing easier.*

*The way StoryShow was used related closely to the classroom's social organization—especially in the roles students played.*

*Independent work in this classroom was common. Students also worked in small groups, helping each other with both technology and non-technology activities.*

captured, the sound or image would automatically get saved into a bank of available sounds and images for later placement. Modification of the sound input facilitated editing by forcing a choice to save or re-record the sound.

The use of a trial run for sounds seems to have developed as a result of hesitations which came up during most of the recordings during the first session. Initially, the sounds were generated on the fly, as they were recorded. During a second session, Julie began the practice of discussing the sound first, then practicing it before attempting to record it. The immediate feedback from the computer seemed to make this editing easier, as children heard their work right away, and then had the option to save it or record it again.

Another curious aspect of the use of *StoryShow* is the gender-related differences in their chosen roles. Donnie and Rick were more interested in having control of the computer through the mouse and microphone, and seemed less interested in adding content to the composition. Julie initiated the turn-taking that allowed everyone to have a role in content, and although both Julie and Amber created two slides each, there was no resistance to this from Rick or Donnie, who each created one. The same orientation to the composing process was apparent in other episodes in which these students were involved, with both boys focused on controlling hardware while Julie had control of content and orchestration.

In this classroom, as in the first and fourth grade classes, the way *StoryShow* was used related closely to the social organization of the classroom, especially in the roles students played, their freedom to move around, and ways of working: cooperatively, independently, or for an audience. While Ms. Boston stated "I'm not terribly comfortable with technology but I've gotten way more so," she also noted that technology, both inside and outside her classroom, had had an effect on the way she taught. At the outset of the ACOT program, Ms. Boston maintained a "lecture-oriented" teaching practice. Students were allowed to become familiar with the computer in a limited way, but it was mainly used to tutor or drill individual students working alone. Over the years, however, she changed her teaching style to better suit her students, who commonly use interactive technologies such as video games and computers, as well as the visually compelling medium of television, outside the classroom. This led her to involve students in more physical ways in the classroom, using dramatization of stories where students act out particular roles within a text, or choral speaking, where students share in the reading of books. In her opinion, a child might tune out sound but respond well to visual information, or vice versa, and providing as many opportunities as possible became important to her. This change in teaching style, Ms. Boston remarked, is in part:

*...Because once again I'm in competition with what's going on outside the classroom, so I think I try to change activities so they're involved. Without technology, they're involved doing dramatization or in choral speaking or in coming up and doing an example. But physically they're involved because I think physically they're involved in a lot of things outside the classroom.*

An additional change was that the computer was no longer studied for knowledge of its components or functions. Ms. Boston's students were already tutored in computer basics in the first grade, so most were already familiar with the keyboard and had begun to master touch typing.

Independent work in Ms. Boston's classroom was common. They wrote daily journals on the computer, and they also helped each other by proofreading and offering suggestions. Students also worked in small groups on computer-oriented tasks and they helped each other in both technology and non-technology activities. Ms. Boston used a process-oriented approach to writing, with a chart on the wall listing various steps in the writing process as a guideline for children — pre-writing, writing, revision, etc. In this classroom, the process of